

A

PROBATIONARY ESSAY

ON

NECROSIS;

SUBMITTED,

BY AUTHORITY OF THE PRESIDENT AND HIS COUNCIL,

TO THE EXAMINATION OF THE

Royal College of Surgeons of Edinburgh,

WHEN CANDIDATE FOR ADMISSION INTO THEIR BODY,

IN CONFORMITY TO THEIR REGULATIONS RESPECTING THE
ADMISSION OF ORDINARY FELLOWS;

BY

ARCHIBALD DOUGLAS, M.D., EDIN :

LICENTIATE OF THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH.

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TO

JAMES SYME, ESQ.,

PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF
EDINBURGH,

THIS ESSAY

IS RESPECTFULLY DEDICATED,

BY

HIS OBLIGED FRIEND

THE AUTHOR.

PROBATIONARY ESSAY

ON

NECROSIS.

THE osseous system which gives form and firmness to the frame, was, till of late years, placed by authors in the lowest class of organized tissues. This the researches of later physiologists have shewn to be exceedingly incorrect; by these it has been clearly established, that the vital functions are performed in bones with considerable activity, and a more perfect anatomy has shewn that they are likewise very freely supplied with blood.

We have the evidence of nutrition taking place in this structure, in the bones increasing in size with the growth of the individual; in their becoming coloured a deeper red when that substance is mixed with the blood, and in the manner in which a fractured bone comes reunited at its broken extremities. We have also the evidence of absorption, in the changes that take place when bones are subjected to pressure, from disuse, collections of matter, aneurisms, &c., and in the disappearing of the red colour produced by

madder when the use of that substance in the food is discontinued.

The sources from which the bones derive their supply of blood are, *first*, the periosteum, a membrane which completely surrounds them, in which the blood vessels ramify to very great minuteness, and from which very attenuated vessels penetrate their structure in every direction; *secondly*, from the osseous arteries, which directly enter their substance, and are distributed through it; and *thirdly*, from the vascular membrane which lines the canal in the centre of the cylindrical bones. This may be regarded as an internal periosteum, and within it the marrow is lodged, which is a substance in all its properties analogous to fat.

Bones in their healthy condition are not endowed with much sensibility, but in a diseased state the sufferings they give rise to are most acute.

In some bones, or in some parts of them, as in the shaft of the femur, the structure is more compact, hard and brittle, and less organized than in others, as in the scapula, and the head of the tibia, where the texture is much looser, has a spongy cellular appearance, and is more highly organized. This difference of structure in a great degree affects their power of resisting disease, and in a most important manner modifies the nature of the disease that attacks them. A slight cause may completely destroy the vitality of

the one, which is harder and less organized ; whilst, if applied to the other, which is softer and more organized, it will be comparatively innocuous. Mr Bell thus speaks of their relative power of vitality :—" In consequence of the extremely compact texture of the walls of the apophyses of bones, and of the comparatively low degree of vitality which they enjoy, they are more easily acted upon by external injuries than the vascular cancellous texture of the epiphyses, and are hence especially apt to mortify. A very slight injury will frequently occasion most extensive exfoliation from the surface of the cylinder of a long bone ; while, on the other hand, a musket ball may in many cases traverse the cellular structure of an epiphysis, or lodge in its substance, without giving rise to such a degree of mischief as a person might have been led to expect. Indeed the cellular texture of the epiphyses, when irritated by the presence of a foreign body, is more apt to put on the suppurative inflammation than to perish by necrosis."

Necrosis is a term now applied to signify equally the death of a whole bone or only a portion of a bone. It was first used in this sense by Louis ; but he confined it exclusively to those cases in which the bone died throughout its whole extent. It is a disease which was well known to the older authors under different names, but by all it was considered of the

same nature as caries; and the two terms were used indiscriminately in their descriptions of these complaints. Necrosis and caries are however essentially different in their nature, general characters and termination. This distinction is now generally recognised, and each term is confined to its separate complaint. The first very closely resembles mortification of the soft parts, the latter ulceration. Weidmann, in his able and practical work, "*De Necrosi Ossium*," thus describes it:—"Nunc vero sicuti ossa inflammatione et suppuratione lædi, sic etiam veluti carnes, gangraena vel sphacelo corripì possunt; quando nempe vis ossium vitalis alicubi omnino extinguitur, vel extincta est, ut pars illa nutrimento suspiciendo in posterum inepta absolvatur, et decidat; id est quod necrosin ossium appello."

The remarkable feature of this disease is, that the living system has the power of reproducing the parts destroyed, and that to a much greater extent than is observed in any of the other tissues of the body. There are instances in which the whole length of the tibia between the two epiphyses has been renewed; and there is a case mentioned in Cooper's *Surgical Dictionary* in which a large portion of the femur was taken away, and yet the limb, except suffering a little in shape, was as useful as ever.

Necrosis has been known to affect all the bones in

the body, even the small bones of the ear. A case of this kind is mentioned by Henri in the "*Journal de Medicine*." But there are some bones in particular in which this disease has been observed to take place more frequently than in others.

The cylindrical bones are certainly most frequently affected—they are also most readily renewed. Of the individual bones, instances of necrosis in the tibia are most common; then probably the humerus, then the femur, next the lower jaw and clavicle, &c.—the radius and ulna, and the smaller bones, are much more rarely attacked. The flat bones, though less liable to necrosis, do not altogether escape; indeed necrosis of the lower jaw, and of the bones of the head, is far from uncommon. When the lower jaw is affected, it is said never to occur before the age of thirty—in it the process of reproduction takes place very readily. Some of these cases, however, display great peculiarities. There are instances mentioned in which the articulating surfaces were included in the disease—a circumstance, it may be mentioned, which very rarely happens, the necrosed portion seldom spreading to the epiphyses, which become united and identified with the new bone. When the joint is destroyed it does not appear that an exactly similar structure is ever reproduced; yet, though the joint be incomplete, in time the individual acquires

the power of moving it with surprising freedom. There is an instance of necrosis having occurred in the scapula, which is related by Chopart. A large portion of the bone died and was removed. In time its place was supplied by a new osseous formation. The new bone did not, however, exactly resemble the old one, it differed in being of a smaller size, a flatter shape, and in not having any spinous process. Pott has mentioned several instances in which, from injuries received on the head, death and exfoliation of the parietal bones took place, but without any reproduction. In cases where necrosis of bones of the head takes place, if the piece is of small extent there will be a partial filling up with osseous matter ; the remainder will be of a membranous nature. When the injury includes a large portion of the bone the cure takes place simply by granulation.

This disease occurs in every different climate—it is not confined to any particular time of life—both sexes are equally subject to it—and no manner of life exempts from its attacks. But though it is a disease to which in a manner every one is exposed, there are certain classes of individuals, and certain periods of life, which come more under its influence. For example, in early youth, when the nutritive function of the bones is in a state of great activity and the growth rapid ; also at puberty, when

great changes take place both moral and physical; and, thirdly, at the variable period when the growth is completed.

Besides these particular periods of life, however, there are other more general and more numerous predisposing causes. There is, in the first place, weakness of constitution. This may arise in two different ways, either from the individual being naturally of a sickly disposition, or from this state having been brought on by long continued bad health. In the second place, some particular diseases have been found more peculiarly to leave a tendency to necrosis; the most important of these are low fevers, small pox and scurvy; likewise persons who have suffered from lues venerea, and who have taken large quantities of mercury, are more predisposed than others. Some have added the particular occupation of the individual, as this disease has been observed most frequently amongst field labourers.

The exciting causes of necrosis are injuries by blows, falls or strains, inflammation, and the application of irritating substances, which either directly destroy the vitality of the part, or excite inflammation in it, such as the cauterium and the different caustics: to these may be added extremes of heat and cold.

The above different ways in which this disease may be induced, have led some authors to classify necrosis

into the traumatic and idiopathic, the latter being the more severe form.

Another cause, according to some, by which necrosis may be produced, is the removal of a portion of the periosteum. They assert, that if a part of the investing membrane be removed the bone at that part will necessarily die. Boyer and others however deny this; they state, that if the patient be not otherwise unhealthy, and the injury be confined to the periosteum, the remaining structures may, and often do, repair the injury by granulations being thrown upon the surface of the bone, and cicatrization taking place; but this requires judicious treatment on the part of the practitioner. All external causes of irritation must be avoided, and the applications must be of the most soothing kind. It will not be wondered at that such an event should frequently happen to those who described it; for, as Weidmann observes, their treatment was so injudicious and irritating, that a bone naturally feebly endowed with a power of resisting injury, and still more enfeebled by a partial removing of its nourishing membrane, having additional daily irritating substances applied to it, its remaining vitality could not but be destroyed. This explanation is quite sufficient, more especially when it is also known, that in those cases where the membrane was removed, and a contrary plan of treatment employed, the cases

terminated happily. Nor do later experiments support the above view, as pieces of the periosteum have been again and again removed from the bones of the inferior animals without having been followed by any such effects.

The length and the depth of the bone necrosed will depend upon the extent and the force of the injury applied, and also upon the part of the bone injured. When a portion of the bone is alone affected, the necrosis is not confined to the part injured; it is always of a very irregular shape, and generally has at its extremity long rounded spiculæ.

The separation of the dead part takes place by a process of the living system termed ulcerative absorption. It takes place exactly at the place where the dead portion terminates, and is analogous to the separation of a slough in the soft parts of the body; but in this (the osseous tissue) the process requires a much longer time to be completed.

A number of ingenious theories have been propounded to explain this process, of which two may be mentioned. The first was advocated by Boyer and others, that this separation was accomplished by means of fleshy granulations shooting in between the dead and living part, and acting like a wedge, thus forcing it off. But Weidmann has shewn that this cannot take place at first, the parts being in such intimate

coherence ; and if the whole circumference were necrosed, it could not act thus at one part without acting in a contrary manner on the opposite side ; besides, these granulations are never observed till the separation is pretty far advanced. The second theory, and which till lately was the common opinion, was, that pus possessed acrid and solvent properties ; and hence it was imagined, that if a bone was for any length of time exposed to its influence its vitality would be destroyed, and that in a further process of time it would be dissolved by that fluid. This is however totally incorrect, analysis shewing that pus does not possess any such properties ; and there are many well known cases of bones having been for years so exposed without having been in the least degree affected by this fluid. Nor is this doctrine sufficiently supported by the fact that, at the bottom of such collections of matter, the bone was found diseased ; for, as Weidmann observes, the same cause which induced the formation of pus may have caused the disease of the bone. He says he has known bones long so exposed, without being in the least degree altered by it.

The appearances which a bone presents when in a state of necrosis are, a colour considerably whiter than natural, a texture harder and more brittle, and if examined with a probe it will emit a sound clearer and

more resonant than sound bone. The diseased portion is sometimes noticed of a black colour, which has been supposed by some to be a peculiarity of the disease ; but this is a change sufficiently explained as being produced by long exposure to the air. In some instances the bone lies deep, and is of the usual white colour ; in others, where it is near the surface and a portion lies bare, the black colour is confined to the extent of exposed surface, the ends beneath the soft parts being found of the white appearance described.

Necrosis may affect a single bone to a greater or less extent, or it may affect several bones at the same time ; or finally, it may affect different parts of the same bone. Hence it has been divided by Weidmann and others into simple and complicated ; simple, when the patient's health is good, and only one bone and one part of the bone is affected ; complicated, when the patient's constitution is in an unhealthy state, when more than one bone, or when more than one part of the same bone is diseased.

An attack of necrosis presents itself under two forms, one chronic, the other acute. When it is chronic, the disease is more obscure and very liable to be mistaken. This latter species is most apt to occur in those whose constitutions are tainted with the scrofulous diathesis, the venereal poison, or scurvy ; or are under the influence of any of the predisposing

causes formerly mentioned ; and also when the necrosis is confined to the external surface of the bone. When the disease is in the acute form, it goes through its various changes more rapidly ; the symptoms general and local are much more severe, and the individual's constitution is in general healthy and robust. In this latter species the pain is excruciating, the constitutional disturbance very great, the fever very high, and not unfrequently attended with delirium.

The swelling, which in the one case is slow of forming, and in the other more rapid, does not present the circumscribed appearance of a local inflammation ; but is so widely diffused that its exact limitation cannot be readily ascertained.

If the diseased bone is deeply covered with the soft parts, the extent of the swelling will depend upon the nature of the obstruction presented to its approach to the surface ; for pus always makes its way outwards through those parts which offer least resistance, and hence the membranes, tendons, fascia, vessels, &c., greatly modify its direction. At first it is not easy to distinguish this swelling from œdema ; but the accumulation of the pus, and its near approach to the surface, render at length a feeling of fluctuation discernible.

When the pus has made its escape it affords great relief to the patient ; the swelling is however very little diminished, and the sore remains open, and con-

tinues to discharge in greater or less quantity ; and small pieces of bone may often be remarked mixed with the matter. If an examination be now made through the opening, either with the finger—should the aperture be large enough—or if not, with a blunt-pointed silver probe, the bone will be found lying bare at the bottom of the cavity.

When the piece of diseased bone is of considerable extent, or when it lies deep, the swelling points in a number of different places. These different openings remain unhealed ; their edges become thickened and callous ; they also contract slightly, and what are called fistulous sinuses are established. These all communicate with the bone, and some of them freely with each other.

Till the disease arrive at the stage at which an examination can be made, its true nature and extent cannot be positively ascertained. It may be suspected, it is true, from the characters above mentioned ; from the deep dull aching pain ; from the swelling appearing to include the bone, and from the sinuses resisting the usual means of cure : besides these, some have affirmed, that the peculiar characters of the pus secreted will indicate pretty correctly the nature of the disease—the leading features mentioned are its being dark, sanious and fetid, as if mixed with the marrow. Weidmann however rejects these as incorrect ; and

says, from his own experience, that he has frequently seen pus with the usual healthy characters, if the person be young and healthy and the other secretions natural. In this case he has seen, he says, the pus yellow and inodorous; but if the patient be unhealthy, of a thin and bad habit of body, and of a sickly constitution, it will then present the above mentioned characters—the features of the purulent secretion not depending upon the particular tissue affected, but upon the healthiness or unhealthiness of the constitution of the individual. The particular characters of the ulcer have likewise been mentioned as affording a good diagnosis of the disease: these are, large pale and flabby granulations—thin sunken and undermined edges—a continued profuse discharge—little pain, and no tendency to heal.

From the different ways in which necrosis has been found to affect the bones, it has been divided into external necrosis, internal necrosis, and necrosis of the whole shaft.

External necrosis is generally the consequence of external injury, hence its frequency in those bones which lie nearest the surface of the body. This form of the disease is not attended with much danger, and commonly is very readily cured.

Its treatment is very simple. Free outlets should be made for the matter, and the patient's strength

should be supported by a nourishing diet as long as the discharge continues. The exfoliation should not be interfered with, as long as it remains attached to the old bone, further than by occasional probing, to discover when it becomes loose. Immediately upon its being disengaged it should be removed. Granulations are afterwards thrown up from the bone, which for the most part supply the place of the dead portion, and the wound cicatrizes. Formerly it was thought advisable to attempt to hasten the cure by sawing off the diseased portion of bone; but this practice was found almost invariably unsuccessful; for it generally happened that an adjoining portion of the sound bone afterwards died, and thus still longer protracted the cure, and still further enfeebled the patient by a second drain upon his strength.

When the necrosis is internal, it is almost always produced by constitutional causes; but there are some instances where it could be traced to external injury, such as the case mentioned by Bromfield, in which a pea was secured from moving about in an issue over the head of the tibia, by applying pressure tightly over it. The pea being situated on the bone, the periosteum was destroyed; the pea made its way into the interior of the bone, and from the irritation thus occasioned a large piece of the spongy substance died; in process of time this separated and was removed, and

the wound healed. In the bones of the cranium the destruction of the internal plate from external injury is by no means uncommon. Mr Russell admits, that in the bones of the cranium internal necrosis may occur from this cause. Of such cases he had himself witnessed many instances ; but he denies that it can, or ever has happened, in any of the other bones. In those cases which are related, he says that sequestra of the whole bone were mistaken for internal necrosis ; but it is difficult to conceive why, if this may take place in some bones it may not also in others. The above case of Bromfield's is a clear instance that such an event has happened.

We have also the authority of Weidmann in support of the occurrence of this form of the disease. He says that he has seen several instances of it ; and gives as the diagnostic mark by which it may be distinguished from a sequestrum of the whole shaft, the roughness of the outer surface of the dead bone. He says that, should the outer surface be rough, it may be concluded that the dead piece is only a separation from the internal part of the bone, and that the enlargement is from the outer shell having thrown out osseous matter. Should, on the other hand, the piece of dead bone be smooth, it may be concluded that the bone has died through its entire thickness, and that the osseous envelope is an entirely new formation.

Internal necrosis commences with a very acute deep-seated pain in the bone, nausea and vomiting, which are probably consequences of the former symptom; these are followed by gradual enlargement of the bone, which on its outer surface becomes rough and tubercled; and afterwards there are swelling and discolouration of the integuments. Pus is copiously secreted in the interior of the bone, which, from its accumulation, greatly increases the patient's sufferings. In a longer or shorter time it causes absorption to take place in the wall of the bone, forming apertures which are termed cloacæ; through these the matter escapes and diffuses itself among the superjacent tissues, giving rise to an abscess more or less extensive. When the abscess bursts or is opened the patient obtains great relief, and the swelling abates considerably, but does not altogether subside. If pressure be applied, it has not the effect of making the matter come out in greater quantity, because coming from the surface of a bony cavity, the pressure does not affect it.

The dead piece of bone, which is named a sequestrum, continues to excite great irritation. If fortunately, (but this is rarely the case) the sequestrum be small, and so placed as to make its escape at one of the cloacæ, the discharge gradually subsides, and the cavity becomes filled up with osseous matter.

If the sequestrum is of such an extent as not to be able to escape, it creates great irritation and a copious discharge; and if not interfered with, hectic fever supervenes, and the patient becomes exhausted and dies. When it is ascertained therefore that its size prevents its escape, means must be resorted to for enlarging the opening and facilitating its removal. This is done by making a free incision down to one of the cloacæ, and applying the trepan over it, and removing a circular portion of the bone. Should the aperture be still too small, the instrument must be again applied at a little distance from the former opening, and the intermediate piece of bone broken down by means of the cutting pliers or Hey's saw. The after part of the treatment consists in applying simple dressing and metallic washes to the wound, and in supporting the patient's strength by a nourishing diet.

Cloacæ are those openings observed in the shell of the bone. They are usually of a small size, and of an oblong shape. Their number seldom exceeds three—more commonly there are only two, or even one. They have been described as being formed by the periosteum having been destroyed at that part, and consequently a corresponding deficiency remaining in the new formation. But if we consider their very small size, and the extensive power of reproduction that exists,

this explanation will hardly be received. They are now considered as merely fistulous openings, and as being formed by ulcerative absorption, induced by the pressure of the pus pent up within the cavity of the bone. They do not always form in that position, which seems best adapted for permitting the escape of the matter; but this is probably owing to that part of the bone having offered the least resistance.

The third form of necrosis is that in which the whole shaft of the bone is implicated in the disease, and in which the necrosed bone is found enveloped in a shell of new osseous matter. The instances of this description of the complaint were for a long time considered as cases only of internal necrosis, and it was denied that the death of the whole shaft ever took place. Later experience, however, has established that this does sometimes take place, but that it is not a frequent occurrence.

When the disease is in this form, one of the most remarkable features which it presents is, that the tendons of the muscles become adherent to the new structure in the same situation they occupied in the old one. Whilst the old bone is separating an effusion of a reddish gelatinous fluid takes place. It varies in extent, sometimes having been observed above an inch thick. It gradually becomes more consistent; bony deposits then form in small patches at different points;

these increase in number, and radiate, and by degrees amalgamate into one mass. Whilst the process of separation of the tendons, again, is being slowly performed, the fluid effused around their insertions gradually fixes them to itself; and in many cases, whilst the whole process is going on, the patient retains the complete use of the limb.

The time that elapses before the cure is completed is very variable, depending on the size of the bone affected. Mr Russell says, that the cure is most rapid when the disease is seated in the lower jaw: and that when the bone of the leg is attacked, the cure may be protracted for one or two years, or longer.

In giving a prognosis as to the result of a necrosis, it is necessary to take into consideration a variety of circumstances. It is generally agreed upon by authors, that, when the disease is simple and confined to the external part of the bone, the patient's life is in no danger. The disease will be tedious, because the changes which take place in that texture are slow; but the cure will be safe and permanent. If the disease is in the internal part of the bone, the danger is much more imminent; for the patient runs a risk, in the *first* place, from the violent inflammation and constitutional disturbance excited at the commencement of the disease; and in the *second* place, the discharge that accompanies the separation of the se-

questrum may exhaust the patient before that process is completed. If, by means of an operation, the sequestrum can be released from its confinement within the shell, the prognosis may still be favourable ; but, if it be necessary to have recourse to amputation, the result is less likely to be fortunate. If the disease happens in more bones than one at the same time—if it affects the large bones to a great extent—if the joints become in any manner implicated—and if the patient's constitution be in any way tainted—then the case will be attended with considerable danger.

In concluding, it only remains to be considered, what is the seat of the reproduction of the new bone. This is a subject attended with a great deal of difficulty, and has given rise to a great deal of discussion. By some it is maintained that bone alone produces bone ; by others that bone is formed from the periosteum ; whilst others again hold that the new bone is formed from the surrounding soft parts alone.

Many authors are of opinion that, when a bone dies, the remaining living parts of the old bone shoot out ossific matter, which elongates and unites with that from the opposite extremity, and is converted into the new shaft. Numerous experiments have been performed on the inferior animals to illustrate this ; and by these it would seem to be shewn, that, if the remaining extremities be but a little way separated

from each other, a union in the above way may take place ; but should the dead piece of bone, or the portion artificially removed, be to the extent of an inch or more, a complete osseous union will not take place. On examining the parts, it will then be found that osseous matter has proceeded from each extremity to a conical point, and that the remaining space is occupied by a fibrous substance.

The second theory, that bone is formed from the periosteum, is of older date than the former. It was first advocated by Du Hammel, who reasoned from a supposed analogy between wood and bone. He conceived that, as in health bone was formed from the inner layer of the periosteum, so in cases of necrosis the inner layer, instead of uniting with the bone now dead, formed the shell of new bone, which with subsequent additions constituted the new shaft. His argument was founded upon a wrong idea of the formation of bone. Instead of being in scales, as he supposed, later physiologists have shewn that the bones are in the form of cells, on the sides of which earthy matter is deposited ; that all bones are formed in the same way ; and that the hard texture of a shaft is similarly constructed with its spongy looking head, the canals being only more closely put together. Nor can it be supposed that the new shell, if formed in the manner now stated, would exhibit

that irregular nodulated appearance it so often presents. And in those cases where the periosteum has been destroyed for some extent, there should be a corresponding vacancy in the new formation; or, at any rate, there should be a much greater deficiency than is usually observed.

A modification of the above opinion is given by Troja, founded upon numerous experiments; namely, that ossific matter is deposited between the surfaces of the periosteum. He described that membrane as in the first place becoming greatly thickened by the effusion of the gelatinous fluid, and then having the osseous matter deposited in this, and finally being converted into the new shell.

Dr Macdonald repeated the above experiments; but he always found, he says, the effusion of reddish fluid to take place within the periosteum—that is to say, between it and the bone.

Boyer, in his “*Traité des Maladies Chirurgicales*,” describes the formation of bone to depend upon whether it be the external periosteum or internal membrane that is destroyed. If it be the former, he says, the growth of the bone takes place from within outwards, the internal membrane being the agent. If the latter, the growth is from without inward, the periosteum being the agent.

On the other hand, there are many authorities who

maintain that the periosteum has nothing to do with the formation of the new bone, which they consider to be produced from the soft tissues which encompass the bone. Mr Bell says,—“ I coincide in opinion with those authors who do not assert that the periosteum, condensed cellular membrane, or fascia which covers the bone, is endowed with such complicated functions as to be able not only to repair its own lesions, but at the same time to secrete osseous matter.” Mr Russell also is opposed to the opinion that bone is formed from the periosteum. He says—“ To me, however, it seems proved almost to a demonstration, that the original periosteum has no share whatever in the formation of the new bone.” He thinks that, if the osseous matter was deposited in the substance of the periosteum, it would not have the rough tubercled appearance observed; and that, if it were so laid down, there would be a limit to the new production by the internal layer of the periosteum, which is not accordant with the fact that, when the sequestrum is removed, the whole space fills up and the mass becomes solid. He thinks that, in some cases of compound fracture, the shell, which is exactly similar in all respects to that formed in common cases of necrosis, forms under circumstances where it is impossible the periosteum could have any share in the process. He instances the case of the ends of a broken bone overlapping each other, and the

union taking place in that position; and what he considers a still stronger case, where the bone is broken into a number of fragments, and that portion of the periosteum destroyed; or when a portion of bone, with its proper periosteum, has been removed, and a vacuity left, yet that vacuity being completely filled up, independently of the periosteum which was torn away. He adds,—“ From a due consideration of every circumstance, it appears that the pulpy mass, which extends from one portion of the bone to the other, and is itself at last converted into bone, is entirely a new creation, and has no dependence upon the original bone or its periosteum. Yet, from whatever part it derives its origin, it serves the purpose of a bed for the ossific granulations to shoot from. There is no necessity that it should originally have any connection with the bone or its membranes, since parts of a nature wholly different from bone are known to ossify in a great variety of morbid cases.” He mentions the tendons, blood-vessels, and the bony concretions sometimes found in cancerous tumours, and in some rare cases in the fatty texture. It will be doubted, however, whether these morbid deposits can correctly be admitted as illustrations of his views. Finally, he asserts, that it is from the surrounding soft parts, and from them alone, that the gelatinous fluid is effused, which becomes converted into the new bone.



